applications. In some embodiments, alloys include metals and materials including, but not limited to, e.g., nickel (Ni), aluminum (Al), titanium (Ti), copper (Cu), zinc (Zn), titanium (Ti), hafnium (Hf), zirconium (Zr), iron (Fe), cobalt (Co), manganese (Mn), gallium (Ga), bismuth (Bi), strontium (Sr), carbon (C), including combinations of these materials. In some embodiments, the alloy is a bi-metal alloy. In one embodiment, the bi-metal alloy comprises nickel (Ni) and titanium (Ti). In one embodiment, the bi-metal alloy includes an atomic ratio [(50+X):(50−X)] for each metal of the alloy, where X=0 to 10. In one embodiment, each metal is about 50% of the total metal content by mole in the alloy. In other embodiments, the alloy contains multiple metals or is a multi-component alloy. Other alloys are within the scope of the invention. Thus, no limitations are intended.

Structured Forms

Solid refrigerants of the invention may take any structured form or shape that allows the solid refrigerant material to be: 1) deformed in a Martensite state, 2) retained (i.e., locked) in the deformed state for a preselected period, and 3) subsequently released (i.e., unlocked) and returned to the non-deformed or austenite state. Structured forms and shapes include, but are not limited to, e.g., rods, bars, wires, wafers, discs, plates, buttons, pellets, spheres, beads, particles, ribbons, meshes, tubes, tapes, pencils, or other structured forms and shapes, including combinations of these various forms and shapes. No limitations are intended. In various embodiments, the structured forms or shapes may be fashioned by processes including, but not limited to, e.g., pressing, casting, extruding, stretching, bending, twisting, pelletizing, or other manufacturing processes including combinations of these various processes. No limitations are intended.

Deformation Tolerances for Solid Refrigerants

Solid refrigerants have tolerances for deformation that range from 0% to about 10% by deformation strain (e.g., 1 cm to ≤1.1 cm; or 1 m to ≤1.1 m and etc.). In other embodiments, deformation tolerances range from about 0% to about 25% by deformation strain (e.g., 1 cm to ≤1.25 cm; or 1 m to ≤1.25 m and etc.). In yet other embodiments, deformation tolerances range from about 0% to about 100% by deformation strain (e.g., 1 cm to ≤2 cm; or 1 m to ≤2 m and etc.). In still yet other embodiments, deformation tolerances range from about 0% to about 200% by deformation strain (e.g., 1 cm to ≤3 cm; or 1 m to ≤3 m, and etc.). The solid refrigerant can be shaped so as to have a structured form that provides preselected deformation tolerances for intended applications and devices.

Cooling Energy Density

The present invention completely eliminates need for halofluorocarbon (HCFC) refrigerants and other conventional refrigerants known in the art that are environmentally unfriendly or otherwise problematic. Moreover, the present invention, for the first time, provides a way to store cold energy in a form other than ice or by gas liquefaction. Solid refrigerants described herein are more efficient than conventional HCFC refrigerants (e.g., SUVA® R410, E. I, du Pont de Nemours and Company (DuPont), Wilmington, Del., USA) known in the art. Systems of the invention described herein further provide at least a 50% better efficiency difference than conventional vapor-compression cooling systems known in the art. Embodiments of the invention also provide a smaller footprint for operation. For example, storing cold energy in accordance with the invention has the potential to provide volume/space savings due to cooling energy density differences of the solid refrigerant. For example, a bi-metal alloy containing, e.g., 50% nickel (Ni) and 50% titanium (Ti), has a power density of about 130 J/cm^3. A conventional HCFC refrigerant has a power density of less than 3 J/cm^3. FIG. **4** presents a differential scanning calorimetry (DSC) plot that shows repeated thermal cycling of a (Ni)—(Ti) bi-metal alloy. Latent heat (Q_1) remains the same regardless of how phase transformation is induced. Phase transformation of the solid refrigerant may be caused by a mechanical stress, by temperature changes, in concert with magnetic fields (e.g., magnetic cooling), in concert with electrical fields (e.g., electrocaloric cooling), or by various combinations of these transformation stressors. Thus, the invention can be expected to find application in various industries. Applications include, but are not limited to, e.g., air conditioning, and air conditioning devices; large-scale devices for home, transportation applications and systems (e.g., delivery vehicles), and like devices and like applications; refrigeration devices; and like applications.

While exemplary embodiments of the present invention have been shown and described herein, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from the invention in its true scope and broader aspects. The appended claims are therefore intended to cover all such changes and modifications as fail within the spirit and scope of the invention.

What is claimed is:

1. A process for cooling a heat exchange medium, the process comprising:

transforming a solid material from a first phase to a second phase by cooling said preselected solid material

retaining the solid material in the second phase using a mechanical means until a preselected event;

cooling an exchange medium by releasing the mechanical means so as to allow the preselected solid material to undergo a phase change from the second phase back to the first phase absorbing heat from and exchange medium; and

reusing said preselected solid material to repeat this process.

2. The process of claim **1**, wherein the solid material is a bi-metal alloy comprising nickel (Ni) and titanium (Ti).

3. The process of claim **2**, wherein the solid material comprises nickel at a concentration between 0 atom % and 60 atom %.

4. The process of claim **1** wherein the solid material is a tri-metal alloy.

5. The process of claim **1**, wherein the solid material has a strain tolerance for deformation that is at least about 10% in at least one dimension.

6. The process of claim **1**, wherein the solid material has a strain tolerance for deformation of up to about 21% in at least one dimension.

7. The process of claim **1**, wherein the exchange medium is selected from the group consisting of air, water, or an organic fluid.

8. The process of claim **7**, wherein the organic fluid is ethanol.

9. The process of claim **1**, wherein said solid material is configured in the shape of a rod.

10. A process for storing and releasing cold, the process comprising:

transforming a preselected solid material from a first phase to a second phase by cooling said preselected solid material; and